COSEWIC
Assessment and Update Status Report

on the

American Columbo
Frasera caroliniensis

in Canada

ENDANGERED
2006

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC 2006. COSEWIC assessment and update status report on the American Columbo *Frasera caroliniensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 21 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Previous report:

Crins, W.J. and M.J. Sharp. 1993. COSEWIC status report on the American columbo *Frasera caroliniensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. 1- 30 pp.

Production note:
COSEWIC would like to acknowledge Tyler William Smith, Carl Rothfels and Erica Oberndorfer for writing the update status report on the American columbo *Frasera caroliniensis* in Canada, prepared under contract with Environment Canada, overseen and edited by Erich Haber, co-chair (Vascular Plants), COSEWIC Plants and Lichens Species Specialist Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la frasère de Caroline (*Frasera caroliniensis*) au Canada – Mise à jour.

Cover illustration:
American Colombo — With permission from Britton and Brown, 1913.

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Catalogue No CW69-14/457-2006E-PDF
ISBN 0-662-43224-X

Recycled paper

COSEWIC
Assessment Summary

Assessment Summary – April 2006

Common name
American colombo

Scientific name
Frasera caroliniensis

Status
Endangered

Reason for designation
A long-lived perennial with 11 to 12 extant Canadian populations. These are fragmented and restricted geographically to a highly agricultural and urbanized region that is subject to continuing habitat loss and degradation. Populations consist primarily of vegetative rosettes with only a few flowering plants produced in a given year. The spread of invasive plants within its habitat is a major threat to the persistence of the species. Further losses of populations due to site development are anticipated.

Occurrence
Ontario

Status history
Designated Special Concern in April 1993. Status re-examined and designated Endangered in April 2006. Last assessment based on an update status report.

COSEWIC
Executive Summary

American Colombo
Frasera caroliniensis

Species information

American columbo (*Frasera caroliniensis*) is a taprooted perennial herb of the gentian family (Gentianaceae). Plants exist most of their lives as a basal rosette of leaves that may be as large as 40 cm long. When flowering stems are produced they have sets of whorled leaves that become progressively smaller toward the top of the plant. Flower clusters are produced from the upper leaf axils. Populations tend to flower synchronously, with individuals producing a single flowering stem 2-3 m tall after 7-15+ years in a vegetative state. Plants die after their first and only flowering season and are, therefore, said to be monocarpic.

Distribution

Frasera caroliniensis is widely distributed in eastern North America, ranging from southern Ontario to northern Alabama and adjacent states. It is not common or abundant anywhere in its range. In Canada, it is known from a total of 22 documented populations of which 12 are extant.

Habitat

Frasera caroliniensis is most commonly associated with open forested slopes, but can also be found in thickets and clearings. Its long lifespan may allow it to persist temporarily in sub-optimal habitats.

Biology

Little detail on the biology of *Frasera caroliniensis* is known except for its floral ecology, which has been well-studied; basic questions regarding the initiation of flowering remain to be answered.

Population sizes and trends

Of a total of 22 known populations nine appear to be extirpated with 7 of these being quite old historic sites. Twelve populations are extant and the status of one other population is uncertain. Of the extant populations, ten are large enough to be

considered secure in the short term. Of these, two may be increasing, and four appear to be stable. Changes in population size cannot be inferred from the remaining extant populations due to the limited data available. Only five of the large populations are in permanently protected habitats, and three face possible or likely eradication due to development. The historic loss of nine populations represents about a 41% decline over the past century. More recent trends are difficult to determine due to the lack of previous population estimates. Because the species grows in a vegetative state as leafy rosettes for a number of years before flowering and subsequently dying, it is difficult to estimate the number of relatively mature individuals in a population when no plants are in flower in a given season when surveys are conducted. This was the case in 2004. A total of 3919 vegetative rosettes were counted in 2004. Only a few flowering stalks from the previous season were observed. In 2005, however, a total of 70 flowering shoots were counted at five of six populations visited. The six sites visited in 2005 yielded an additional count of 419 rosettes (updated information). These were found at two new sites (#21 and #22) and at a new subpopulation (#9B). Approximately the same numbers of rosettes as estimated in 2004 at the largest population in Short Hills Provincial Park were confirmed in 2005. Rosettes were too withered and difficult to count at one other site (#12). The estimated total number of plants in 2005 is in the order of perhaps 4200, with all but a few being vegetative.

Limiting factors and threats

Ongoing loss of habitat in southern Ontario and the encroachment of exotic invasive species are the primary threats identified for *Frasera caroliniensis*. As already noted, planned development of several of the largest populations will cause further losses in the medium term.

Special significance of the species

Frasera caroliniensis has been valuable in investigations of the biogeography of the eastern deciduous forest.

Existing protection

The species is listed as Threatened in New York and Endangered in Pennsylvania. It is regarded as special concern by COSSARO (Committee on the Status of Species at Risk in Ontario).

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5th 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2006)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and it is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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SPECIES INFORMATION

Name and classification

Scientific name:	*Frasera caroliniensis* Walter
Synonyms:	*Swertia caroliniensis* (Walter) Kuntze
Common name:	American Columbo
Family:	Gentianaceae (Gentian family)
Major plant group:	Eudicot flowering plant

American columbo was first described as *Frasera caroliniensis* Walter, but many subsequent authors have included *Frasera* Walter within the cosmopolitan genus *Swertia* L. (e.g. Fernald, 1950). A worldwide revision of *Swertia* is needed to resolve this issue (Crins and Sharp, 1993). Most recent eastern North American floras (e.g. Wofford, 1989; Gleason and Cronquist, 1991; Voss, 1996) recognize *Frasera* at the generic rank. No author has disputed the validity of *Frasera caroliniensis* Walter as a species.

Morphological description

Frasera caroliniensis is a robust perennial herb with a thick taproot. Each year it produces a basal rosette of 3-25 oblong deciduous leaves. Reproductive individuals form a single flowering stem 2-3 m tall. Stem leaves grow in whorls of 4(5), the lower similar to those of non-flowering rosettes and up to 40 cm long, the upper progressively shorter. The pyramidal inflorescence is composed of long-pedunculate cymes arranged in whorls from the upper axils (Figure 1.). The four petals are united at the base, forming a saucer-shaped greenish-yellow flower 10-20 mm long, with numerous dark spots or streaks. Each petal is yellow below its middle with a large circular gland conspicuously fringed along the margins. The fruit is a compressed ellipsoid capsule 1.5-2 cm long. Capsules contain 4-14 dark brown, crescent-shaped winged seeds (Crins and Sharp, 1993 and references therein). Individual plants flower only once, after 7-15 or more years of growth, as discussed below.

Frasera caroliniensis is unmistakeable in flower and fruit. The fruiting stems may be up to 3m tall and persist for a year or more (Threadgill *et al.*, 1981a). Illustrations appear in Threadgill *et al.* (1981a), Holmgren *et al.* (1998), and on the United States Department of Agriculture PLANTS website, http://plants.usda.gov/ (USDA NRCS, 2002).

Genetic description

No genetic assessment of this species has been conducted.

Figure 1. *Frasera caroliniensis* (Britton and Brown, 1913)

DISTRIBUTION

Global range

The historic range of *Frasera caroliniensis* is from south-eastern Oklahoma and north-eastern Louisiana east to north-western South Carolina, north to southern Ontario and southern Michigan, as shown in Figure 2 (Threadgill *et al.*, 1979; Crins and Sharp, 1993). It may have been extirpated from Louisiana (Reid, 2004).

Canadian range

In Canada, *Frasera caroliniensis* is restricted to extreme southern Ontario, where 22 populations have been documented, as shown in Figure 3. Seven of these populations have not been seen in more than 49 years, suggesting a 1/3 decline in the Canadian range of the species. This is largely due to the loss of one historic population near Sarnia. The largest of these populations occupies at most 1 ha, so that the area of occupancy (AO) for this species is no more than 13 ha. While the total geographic area of the Canadian population spans hundreds of square kilometres, most of this area has been developed for urban or agricultural use. The historical extent of occurrence (EO) is estimated at 8000 km^2, while the current EO is closer to 2000 km^2, mainly due to the presumed extirpation of the Sarnia population. Detailed location data for all populations are on file at the Ontario Natural Heritage Information Centre.

Figure 2. Global range of *Frasera caroliniensis* (after Crins and Sharp, 1993).

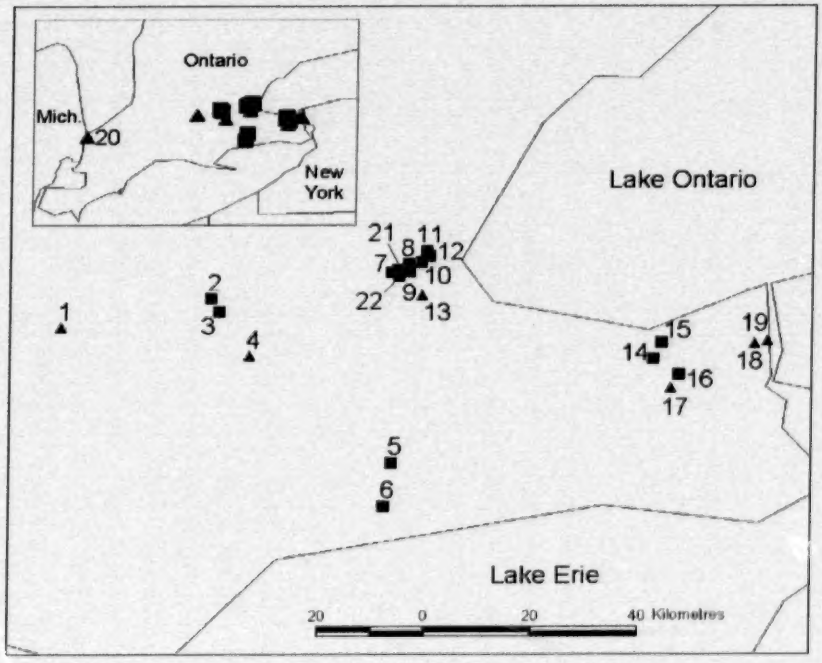

Figure 3. Canadian range of *Frasera caroliniensis*. Squares represent populations verified since 1986, triangles represent historic populations not seen since 1956; numbers refer to sites listed in Table 1.

HABITAT

Habitat requirements

Frasera caroliniensis grows in relatively stable habitats — primarily open deciduous forest, but also in open forest edges and dense shrub thickets. Threadgill *et al.* (1979) note its occurrence in a variety of habitats across its range, including deciduous, pine and red cedar forests, thickets, open meadows and grasslands. They note that it is most common in dry upland woods, but has also been collected from swampy areas. It has been collected on rocky hillsides throughout its range, but will grow on a wide variety of soils. While *F. caroliniensis* has been documented in recently disturbed habitats, Threadgill *et al.* (1979) suggest that such collections may represent the persistence of long-lived individuals despite unfavourable conditions, rather than any actual preference or tolerance for successional habitat.

The range of *Frasera caroliniensis* encompasses a broad climatic gradient, from hot, humid summers and mild winters in the south to more moderate summers and harsh winters in the north (Threadgill *et al.*, 1979). Climatic water stress is not normally encountered during the growing season anywhere in this range, although edaphic conditions at some sites may result in seasonal drought conditions (personal observation).

The Canadian populations of *F. caroliniensis* are restricted to the "Carolinian" forest region, climatically the mildest area of southern Ontario (see pages 25-30 in Waldron, 2003). It is not known if climate is a limiting factor at the northern edge of its range in Canada, or if it may be possible for *F. caroliniensis* to expand its range further north. The Halton region populations occur on dry mesic to mesic clay or clay loam soils in open oak-maple (*Quercus alba*, *Quercus rubra*, and *Acer saccharum*) forests, thickets (*Cornus* spp., *Viburnum rafinesquianum*, *Rhus typhina*, *Rubus* spp.) and openings (Crins and Sharp, 1993, personal observations). The provincially rare perfoliate bellwort (*Uvularia perfoliata*) co-occurs with *F. caroliniensis* in Halton (personal observation). Common herbaceous associates include woodland sunflower (*Helianthus divaricatus*), Pennsylvania sedge (*Carex pensylvanica*), poverty oat-grass (*Danthonia spicata*) and various asters (*Aster* spp.) and goldenrods (*Solidago* spp.).

The Paris site is at the base of a steep slope on mesic silty clay soil under white birch (*Betula papyrifera*), eastern white pine (*Pinus strobus*), and large-toothed aspen (*Populus grandidentata*). A more extensive list of associated species was compiled by Crins and Sharp (1993).

Habitat trends

Forest habitat has been reduced from 80% to 11% of the total area of the Carolinian region (Carolinian Canada, 2004). Historically much of this loss has been attributable to agricultural development, but urban development is now a major cause of natural habitat loss in southern Ontario (Pim and Ornoy, 2002).

Habitat protection/ownership

Two of the extant populations occur in provincial parks, Selkirk Provinical Park (#6) and Shorthills Provincial Park (#16). There are two populations in nature sanctuaries managed by Royal Botanical Gardens (RBG), Hendrie Valley (#9) and Cootes Paradise (#22). The Borer's Creek population (#7) is in the Borer's Creek Conservation Area (Hamilton Conservation Authority). The Glen Morris population (#2) is on land managed by the Grand River Conservation Authority. The Cartwright population (#21) is in a nature sanctuary owned and managed by the Hamilton Naturalists' Club (Rothfels, 2005). The Blue Lake population (#3) is on private property, but the current landowner has demonstrated a willingness to protect the population. Portions of the King Road populations (#11 & #12) and a portion of the Clappison Escarpment Woods (#8) population are located in powerline right-of-ways. Management of these areas does not appear to be having a negative impact on *F. caroliniensis* populations (Crins and Sharp, 1993). All of the remaining eleven populations are on private property, with no existing protection.

BIOLOGY

Frasera caroliniensis was the focus of a Masters thesis completed by Paul F. Threadgill in 1979. Much of his research focused on the unusual reproductive

behaviour of this species: *F. caroliniensis* is a monocarpic perennial. Monocarpic perennial plants live for many years, but flower only once and then die (Harper, 1977). In eastern North America this life history strategy is usually associated with weedy biennial or short-lived perennial species that thrive in frequently disturbed habitats. *Frasera caroliniensis* differs from such species in its much longer life span and affinity for stable habitats. Threadgill and his supervisors published a series of papers on the biology of *F. caroliniensis*, and nearly everything that is known about this species was first documented in these publications (Threadgill *et al.*, 1979, 1981a, b, c; Baskin and Baskin, 1986). It should be noted that this research was conducted in Kentucky. The results should therefore be generally applicable to Ontario populations, but specific details may vary. Phenology in particular would be expected to vary between Ontario and Kentucky populations; the flowering times reported by Threadgill *et al.* (1981a) are slightly earlier than those observed in Halton (personal observation).

Several other more recent papers on this species were reviewed for information on the biology but contained little significant data (Pringle, 1993; Horn, 1997; Floyd and Huneycutt, 2000).

Life cycle and reproduction

Many floras refer to *F. caroliniensis* as a biennial, triennial, or short-lived perennial (Threadgill *et al.*, 1981a). However, McCoy (1949) noted that it requires six or seven years of growth before flowering, but provided no evidence to support his statement. Steyermark reported that a plant transplanted to his garden had not flowered in 15 years (1963 - cited by Threadgill *et al.*, 1981a). Following several years of intensive research, Threadgill *et al.* (1981a) could not determine how old a plant needed to be to flower. His evidence suggested that size was likely an important factor. However, the largest juvenile plants were bigger than the smallest flowering plants, indicating that size was not the only limiting factor.

Indeed, Threadgill's data revealed a strong tendency for populations to bloom synchronously, echoing the observations of earlier workers. Threadgill hypothesizes that this may be part of an evolutionary response to pollinator competition. By storing up resources over many years prior to flowering, plants can produce massive inflorescences when they finally reach reproductive maturity. By flowering synchronously the population provides an overwhelming abundance of flowers for local pollinators. As a consequence the pollinators can temporarily ignore other nectar sources, and in the process maximize the intraspecific transfer of *F. caroliniensis* pollen.

This reproductive strategy depends on the presence of generalist pollinators, as any pollinator specializing in *F. caroliniensis* would face local extinction in the years between flowering events. Understanding pollinator dynamics is an important component of plant conservation (Leigh, 2003; Morris, 2003), but the available evidence for *F. caroliniensis* suggests it should not be the source of major concern in this case. Threadgill *et al.* (1981b) found a number of hymenopterans in the family Apidae to be the most effective pollinators for *F. caroliniensis*, including the common, widespread

generalist pollinator *Apis mellifera* and several *Bombus* spp. In light of this information, it is unlikely that *F. caroliniensis* is vulnerable to the loss of its most important pollinators.

Herbivory

Threadgill *et al.* (1981b) also discussed the possible role of irregular synchronous flowering in *F. carolinensis* as a strategy to avoid seed predation. They found 25% of the seed crop in 1976 was lost to invertebrate seed predators, but more research is needed to determine how important seed predators are in this species. We observed gastropods feeding on *F. caroliniensis* foliage during the 2004 field season, but could not determine if they presented a serious threat to the plants.

Physiology

Little is known of the physiology of this species, other than what can be inferred from the climatological conditions that occur across its range (Threadgill *et al.*, 1979).

Dispersal/migration

Frasera caroliniensis has a peculiar form of seed dormancy, described by Threadgill *et al.* (1981c) and Baskin and Baskin (1986). Seeds remain dormant until they have imbibed water and undergone a period of embryological development at about 5°C. Embryological development does not occur at higher temperatures. As a consequence seeds that drop in the fall or early winter will imbibe moisture from the soil, undergo the necessary development cycle, and germinate the following spring. Seeds that remain within the capsule until late winter or the following spring are kept dry, preventing them from completing the embryological development until the following winter, finally germinating the second spring after flowering. This effectively spreads the germination of a single year's seed crop over two (or potentially three) years. As Baskin and Baskin (1986) explained, "such a germination pattern may be important in maintaining a wide spread of distribution of sizes and ages of plants in the population...[buffering] this long-lived monocarpic perennial with synchronous flowering against extinction at the local population level by ensuring that many plants remain vegetative in a flowering year."

No data are available regarding the dispersal of this species. It is apparently gravity dispersed, making it extremely unlikely to disperse across areas of unsuitable habitat, such as between existing Canadian populations or between Canadian and American populations.

Interspecific interactions

Threadgill's (1981b) study of floral ecology, discussed above, is the only known investigation of interspecific interactions involving *Frasera caroliniensis*.

Adaptability

As mentioned above, the long lifespan of this species may allow it to persist temporarily in degraded habitats. This species was propagated experimentally as part of a conservation seed bank program at Royal Botanical Gardens in Hamilton, but no *ex situ* stock remains.

POPULATION SIZES AND TRENDS

Search effort

In 2004 the writers surveyed nine populations (2, 3, 5, 8, 9, 10, 11, 14 and 17; see Table 1) over six days in the field between July 13 and July 30, 2004. They succeeded in locating plants and conducting censuses at all but populations 5 and 17. Populations 8 and 11 were revisited on August 13 and population 12 was also visited on this latter date. No additional plants were located at sites 8 and 11 and none were seen at site 12. It may have been too late in the season by this time.

Table 1. Summary of Canadian *Frasera caroliniensis* populations.

Site	Last Observation	Number of Plants	Comment	Threats
1 Innerkip	1918	Unknown	Never relocated; vague location data	
2 Glen Morris	2004	862	Three subpopulations; population apparently increasing, but may be a result of great search intensity in 2004	Invasive plant species: *Melilotus, Rhamnus.* Habitat protected
3 Blue Lake	2004	745	Private landowner interested in protecting this population; numbers increasing as a result	A variety of invasive plant species; historically grazed, managed as picnic area.
4 Brantford	1930	Unknown	Never relocated, vague location data	
5 Oriskany Sandstone Formation	1989	"Several"	No plants found in 2004	Heavily impacted by recent logging and *Alliaria officinalis*
6 Selkirk Provincial Park	2004	105	Plants scattered in several locations at this site. Population stable since 1997, when >100 plants were noted.	Canopy closure may be shading plants; Invasive species: *Rosa multiflora, Rhamnus* spp. Habitat protected.
7 Borer's Creek	1989 2005	(less than 10 plants none flowering) none	Incidental observation by D. Kirk Directed 2 hour search at same UTM none found D. Kirk/R. Hay	Habitat protected.

Site	Last Observation	Number of Plants	Comment	Threats
8 Clappison Escarpment Woods	2004	513 total: two subpopulations of 329 and 184 plants	10 observations since 1950, all indicating a sizable population, although we failed to locate one of the two subpopulations in 2004 (may have left it too late in the season).	Habitat may be developed in future
Bridgeview	2004	(329) slope: 168 hydro line: 161 plants	P. O'Hara/J. Ambrose later C.J. Rothfels, E.C. Oberndorfer, P. O'Hara, S. Rehman (somewhat separate from other obs. at this EO)	Small trails, some dumping, invasive species: *Alliaria, Cynanchum, Rhamnus, Lonicera.*
Snake Road	2004	(184)	Dense shrub-thicket.	Many invasive species
	2005	19 vegetative plants none flowering	Directed search by R. Hay	
9A Hendrie Valley	2004	153	Population first reported in 1937. Apparently stable.	Erosion, informal trail, *Rhamnus cathartica, Alliaria officinalis*
9B Hendrie Valley	2005	120, 18 in flower	Newly discovered, ca. 200 m from Hendrie Valley A	This habitat is protected, but the owner has no capacity for management
10 Sassafras Woods	2004	531	ca. 50% decline since 1990	Some human disturbance, invasive species present.
	2005	100s	Hundreds of vegetative plants, too difficult to count due to withered leaves, 5 with flowering stalks D. Kirk/R. Hay	Recent logging in the area, site may be developed in future.
11 King Road East	2004	204	500 plants recorded in 1982. The 2004 plants are from a new subpopulation; the original population could not be located (perhaps too late in the season).	Erosion and *Melilotus alba*; future industrial development expected to destroy site
12 King Road West	1986	270	No plants found in August 2004. Search may have been too late in the season.	Future industrial development expected to destroy site
(Hanson Brick Yard) same site as above	2005	3 flowering stalks	rosettes too difficult to count - very withered D. Kirk/R. Hay	
13 Hamilton	1933	Unknown	Never relocated, vague location data	
14 Sixteen Mile Creek	2004	67	First documented in 1966; no previous population estimates	Invasive plants: *Alliaria, Hesperis*; informal trails, refuse dumping.
15 Fifteen Mile Creek	1987	Unknown	Location and abundance data unavailable	

Site	Last Observation	Number of Plants	Comment	Threats
16 Short Hills Provincial Park	1998 2005	1? 1000 estimate	Few details with 1998 report. ca. 1000 plants seen in 1995. approx. 500 plants in wooded area, plus hundreds in open area 14 flower stalks D. Kirk/R. Hay	Protected habitat, no on-site staff for management.
17 Twelve Mile Creek	1956	Unknown	No plants found in 2004, despite considerable search effort.	Good habitat, but lots of invasive *Rosa multiflora*
18 St. Davids	1897	Unknown	Possibly extirpated – vague location data and no sightings in more than a century	
19 Queenston Heights	1911	Unknown	Probably extirpated	
20 Sarnia	1896	Unknown	Never relocated, probably extirpated	
21 Cartwright Property	2005	287 plants, 24 in flower	A. Ernest, Hamilton Naturalists Club Property	Habitat protected with volunteer management.
22 Cootes Paradise	2005	12 plants, 6 in flower	Newly discovered	Habitat protected, but the owner has no capacity for management

Note: Data from several sites for 2005 were provided, subsequent to the completion of the report, by the Natural Heritage Information Centre, Peterborough, ON.

Donald Kirk and Rebecca Hay searched site 12 in 2005 and found 3 flowering stalks and an indeterminate number of vegetative rosettes. The authors also discovered two new populations in 2005, one in the Cootes Paradise sanctuary of Royal Botanical Gardens (#22) and one in the Cartwright nature sanctuary, recently acquired by the Hamilton Naturalists' Club (#21; Rothfels, 2005). Additional population data were collected at four other sites in 2005 (9, 10, 12, 16), and no plants could be found at a fifth site (7), which is now presumed extirpated.

Populations were censused by intensively searching potential habitat at each site, and the population estimates presented are the result of a direct count of plants. This method provides valuable baseline data, but several limitations make it difficult to accurately assess population trends. First, and most critically, the majority of previous population assessments were conducted in a haphazard manner, as the observers were usually documenting *Frasera caroliniensis* populations only incidentally in the course of fieldwork in service of other objectives. For example, the writers found considerably more plants at population 2 in 2004 than had been previously documented; it is difficult to determine if this represents an actual increase in this population, or only reflects a greater search effort in the 2004 survey.

A second confounding factor is the reproductive biology of *Frasera caroliniensis*. As a monocarpic perennial with synchronous flowering, a large proportion of any population will bloom and die the same year, producing a temporary decline in numbers.

Single-season surveys may therefore underestimate plants at populations that have recently flowered. This may have been the case at population 10, where the writers recorded approximately half the numbers that were seen in 1990.

The only way to address these issues is to establish regular, ongoing population monitoring. This is beyond the scope of status assessment, but is usually incorporated in recovery planning.

Abundance

With the above limitations in mind, the present data do provide a good basis for assessing the abundance of *Frasera caroliniensis* in Canada. Using the writers' own data and that available in the Natural Heritage Information Centre database, the total Canadian population of vegetative rosettes was 3919 in 2004. More limited fieldwork in 2005 revealed a total of 70 flowering shoots at 6 populations, as noted in Table 1.

Assessing population structure of this species in Canada is difficult. *Frasera caroliniensis* has essentially three age classes, seedling, juvenile and reproductive adults. However, we are unable to accurately predict when an individual will make the transition from juvenile to adult. This leaves superficial categorization into size classes as the only tool for field biologists. Most of the populations surveyed appeared to consist primarily of individuals of approximately the same size. The only exception was Clappison Escarpment Woods, where plants demonstrated a range of different sizes. None of the previous records available from the NHIC contain any indication of size or age structure. Since only rosettes of living plants were counted and there was no way of determining which rosettes might have been sufficiently mature to produce flowers the following year, the actual number of mature and potentially reproductive individuals for 2004 is unknown and a total of only 70 flowering shoots were recorded at 6 populations/subpopulations in 2005. It is impossible to determine, with the present data, how many vegetative shoots, in addition to those flowering, might be considered sufficiently mature to be counted as mature individuals.

The estimated total number of plants in 2005 is in the order of perhaps 4200, with all but a few being vegetative.

Fluctuations and trends

Of all the recently located populations, perhaps four should be considered stable: 6, 8, 9, and 16. Two populations may be increasing: 2 and 3. However, this increase may be an artifact of greater search intensity in 2004, as mentioned above. Population 10 is relatively large, but recent surveys suggest large fluctuations between years. More detailed population monitoring is required to clarify the status of this population. Similarly, the Cartwright population (21) is large, but as it is newly discovered we have no basis for assessing population trends. The landowners for populations 11 and 12 intend to expand industrial development at those sites in the future, and similar activities have destroyed most of these populations over the past twenty years.

Nine historic populations dating from 1896 to 1956 are likely extirpated (1, 4, 5, 7, 13, 17, 18, 19, 20). The three remaining populations are small (14, 22) or of uncertain status (15). The historic loss of nine populations represents about a 41% decline over the past century.

In summary, of the ten large *F. caroliniensis* populations in Ontario, only half are in protected areas (2, 6, 9, 16, and 21), and two face extirpation in the near future (11, 12). The others are vulnerable to a change in land ownership or a change in the priorities of the current land owners. However, the density of populations in southwest Halton, and the existence of extensive potential habitat along the Niagara Escarpment suggest that further populations may await discovery.

Rescue effect

Natural dispersal of *Frasera caroliniensis* from the United States of America into Canada is likely exceedingly rare, if it occurs at all. The Niagara River, Lake Erie, and the Detroit River provide serious barriers to plants that do not have any obvious adaptations to bird-dispersal. In any case, habitat loss is a far more pressing concern for this species than limited recruitment.

LIMITING FACTORS AND THREATS

The most immediate threat facing this species is invasive plants. Many of the sites visited by the authors were heavily infested by exotic species, including *Alliaria petiolata, Rhamnus cathartica, Hesperis matronalis, Berberis thunbergii, Rosa multiflora, Cynanchum rossicum, Melilotus alba* and *Lonicera tatarica*. Habitat disturbance, in the form of trails, dumping, and logging are also a concern. Several of the largest populations face development threats, notably 10, 11, and 12. Threats for particular populations are noted in Table 1. Except where noted in Table 1, no information regarding habitat trends at individual populations is available.

SPECIAL SIGNIFICANCE OF THE SPECIES

The species has an unusual reproductive mode and is the only member of the genus in Canada. *Frasera caroliniensis* was also one of ten species used to demonstrate the southern extension of the mixed mesophytic forest Blufflands into Louisiana along the Mississippi River (Delcourt and Delcourt, 1975). As such this species may be of interest in further biogeographic studies of the eastern deciduous forest. Relatively little is known about the historical biogeography of forest herbs in eastern North America and investigators have only recently begun to explore this issue (Griffin and Barrett, 2004).

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Threadgill *et al.* (1979) noted that although *Frasera caroliniensis* is widespread, it is not common or abundant anywhere in its range. Following the Nature Serve ranking (NatureServe, 2004), it is globally secure (G5). However, it is critically imperiled (S1) in Alabama, Oklahoma, Pennsylvania, and South Carolina, imperiled (S2) in Mississippi, New York, North Carolina, and vulnerable (S3) in Georgia. It is considered secure (S5) in Kentucky, but has not been ranked for the rest of the states where it occurs. *Frasera caroliniensis* is a listed Threatened species in New York (Young and Weldy, 2004) and an Endangered species in Pennsylvania (Anonymous, 2004). It may be extirpated in Louisiana (SH). In Canada it is nationally (N2) and provincially (S2 – Ontario) imperiled. It was designated as special concern by COSEWIC in 1993 (http://www.cosewic.gc.ca/eng/sct1/searchform_e.cfm), and is listed as special concern on the Ontario SARO list (http://www.ontarioparks.com/saro-list.pdf).

TECHNICAL SUMMARY

Frasera caroliniensis
American columbo
Range of Occurrence in Canada: Ontario

frasère de Caroline

Extent and Area Information	
• *Extent of occurrence (EO)(km²)* **Estimates based on all 22 historical populations and 12 current populations.**	8000 km² historically 2000 km² at present based on extant populations
• *Specify trend in EO*	Decline
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (km²)* **Estimate based on 12 extant populations with a maximum extent of 1 ha each**	<1 km² (12 ha)
• *Specify trend in AO*	Decline
• *Are there extreme fluctuations in AO?*	No
• *Number of known or inferred current locations*	12 + 1 uncertain
• *Specify trend in #*	Mainly historical decline, but 2 recent losses
• *Are there extreme fluctuations in number of locations?*	No
• *Specify trend in area, extent or quality of habitat*	Decline
Population Information	
• *Generation time (average age of parents in the population)*	7-15+ years
• *Number of mature individuals*	Unknown but 3919 vegetative rosettes were counted in 2004 New data for 2005 indicates that there are in the order of 4200 plants including only about 70 in flower at 6 sites surveyed.
• *Total population trend:*	
• *% decline over the last/next 10 years or 3 generations.*	Unknown overall, with some populations stable, others increasing or decreasing
• *Are there extreme fluctuations in number of mature individuals?*	Probably not
• *Is the total population severely fragmented?*	Yes
• *Specify trend in number of populations*	Mainly historical decline
• *Are there extreme fluctuations in number of populations?*	No
• List populations with number of mature individuals in each: See Table 1	
Threats (actual or imminent threats to populations or habitats)	
- Sites are highly disrupted by the presence of several invasive exotic plants. - Habitat disturbance, in the form of trails, dumping, and logging are also of concern. - Potential loss of three populations is anticipated due to development activities.	

Rescue Effect (immigration from an outside source)	
• *Status of outside population(s)?* **USA:** Widespread but not abundant in the USA, rare (S2) in NY, nearest state to Canadian populations	
• *Is immigration known or possible?*	Extremely unlikely
• *Would immigrants be adapted to survive in Canada?*	Probably
• *Is there sufficient habitat for immigrants in Canada?*	No
• *Is rescue from outside populations likely?*	No
Quantitative Analysis Inadequate data for quantitative analysis	N/A
Current Status COSEWIC: Special Concern (1993) Endangered (2006)	

Additional Sources of Information: A literature search using *Frasera caroliniensis*, *Swertia caroliniensis*, American Columbo, Inuit Knowledge, Indigenous Knowledge, Traditional Knowledge, Aboriginal Knowledge, Native Knowledge and Indian Knowledge as keywords produced no results.

Status and Reasons for Designation

Status: Endangered	**Alpha-numeric code**: B1 ab (ii, iii, iv, v) + 2ab(ii, iii, iv, v) C2a(i)

Reasons for Designation:
A long-lived perennial with 11 to 12 extant Canadian populations. These are fragmented and restricted geographically to a highly agricultural and urbanized region that is subject to continuing habitat loss and degradation. Populations consist primarily of vegetative rosettes with only a few flowering plants produced in a given year. The spread of invasive plants within its habitat is a major threat to the persistence of the species. Further losses of populations due to site development are anticipated.

Applicability of Criteria

Criterion A: (Declining Total Population): Not applicable. Although a 41% decline based on the loss of 9 of 22 populations has been documented, 7 of these losses were historic and most likely well beyond the 10 years or 3 generation timeframe.

Criterion B: (Small Distribution, and Decline or Fluctuation): Meets Endangered B1 ab (ii, iii, iv, v) +2ab(ii, iii, iv, v) due to the small Extent of Occurrence and Area of Occupancy that fall below critical values, the presence of 11-12 extant populations that are highly fragmented and the continued decline in quality of habitat. This can be inferred due the presence of sites in a highly agricultural and urbanized region that has been subjected to extensive ongoing losses in forested habitats and the presence of a series of invasive plants within its habitat. Two populations have seemingly also been lost since 1989 and future losses due to site development are inferred at three other localities.

Criterion C: (Small Total Population Size and Decline): Meets Endangered C2a(i). The total number of rosettes counted, as of 2005, was about 4200 but the majority of rosettes likely represent vegetative plants that are not mature and not ready to flower. As of 2005, an incomplete inventory from 6 of the 12 extant sites yielded only 70 flowering plants at 4 sites with the largest number at a single site being 24. It is unlikely that a single population would have more than 250 mature (flowering) plants.

Criterion D: (Very Small Population or Restricted Distribution): Meets Threatened D2 due to the very small area of occupancy comprising <1km^2 from which can be inferred that stochastic events could impact the populations. The populations also occur within a highly urbanized region where habitat degradation and loss can be expected to continue. Site development at three localities may also result in population losses.

Criterion E: (Quantitative Analysis): Not available.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

Mary Gartshore, Paul O'Hara, Sami Rehman, Jim Pringle and Katherine Kitching provided valuable assistance in the field. Mike Oldham provided data from the Ontario Natural Heritage Information Centre element occurrence database, and Brenda Axon provided supplemental information on the Halton populations.

Additionally, the following people were consulted. Those marked with an asterisk responded with information regarding one or more of the populations discussed in this report: Albert Garofalo, Anthony Goodban, Bill Crins*, Bill Lamond, Bill McIlveen, Bob Bowles, Bruce Duncan, Carole Ann Lacroix, Dale Leadbeater, Dan Brunton, Dirk Janas, Don Sutherland, Donald Kirk*, Dorothy and John Tiedje, George Bryant,; Hank Postma, Jane Bowles, Jim Dougan, Jim Goltz, John Ambrose*, John Morton*, Judith Canne-Hilliker, Karl Konze, Kim Barrett, Larry Lamb*, Madeline Austen, Mary Ann Johnson, Mary Gartshore*, Melinda Thompson, Paul Catling, Paul Eagles*, Paul O'Hara, Peter Ball, Ron Hepworth, Sarah Mainguy, Scott Sampson, Shari Wiseman, Steve Darbyshire, Steve Newmaster, Steve Varga, Alan Anderson, Todd Farrell, Walter Muma, Wasyl Bakowsky, Peter Achuff, and Alan Dextrase. Funding was provided by the Canadian Wildlife Service, Environment Canada.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Tyler Smith completed a B.Sc. in Ecology at the University of Guelph. He has eleven years professional experience as a naturalist and field biologist. He was employed as the field botanist for Royal Botanical Gardens from 1998 until 2002, where he was responsible for curating the RBG herbarium (HAM), vegetation monitoring for the Cootes Paradise wetland restoration, and development and implementation of conservation projects for species at risk. He is currently a Ph.D. candidate in the Plant Science Department at McGill University, researching the systematics and ecology of *Carex* section *Porocystis*. Tyler has published a number of articles and reports on habitat restoration, endangered species conservation, and the flora of Hamilton, including the recovery plan for few-flowered club-rush (*Trichophorum planifolium*). He co-authored the COSEWIC update status report for small-flowered lipocarpha (*Lipocarpha micrantha*), broad beech-fern (*Phegopteris hexagonoptera*), and green dragon (*Arisaema dracontium*).

Carl Rothfels graduated from McMaster University with a B.A.Sc. Combined Honours Biology. He has been a naturalist in a professional capacity since the early 1990s, including six years as an interpretive naturalist in Algonquin Provincial Park. While at Algonquin he undertook the curation of the Algonquin Museum Herbarium (APM), and updated the Checklist of the Vascular Plants of Algonquin Provincial Park. He has published several articles on the distribution and ecology of exotic species, including *Lythrum hyssopifolia* L. and *Hesperis matronalis* L., and he has contributed dozens of new plant records for Algonquin Park, York Region, and the new City of Hamilton. Carl is currently employed as the principal researcher for Royal Botanical Gardens' rare and endangered plants program, as the curator of their herbarium (HAM), and as their natural lands steward. In addition to his botanical experience, Carl is an avid birder and entomologist. He co-authored the COSEWIC update status reports for broad beech-fern (*Phegopteris hexagonoptera*) and green dragon (*Arisaema dracontium*).

Erica Oberndorfer graduated from McMaster University with an Honours B.A.Sc. She has worked on a number of ecological restoration and conservation projects at the Royal Botanical Gardens, including fieldwork contributions to the few-flowered club-rush (*Trichophorum planifolium*) recovery plan and the small-flowered lipocarpha (*Lipocarpha micrantha*) status report, the joint RBG and Six Nations ethnobotany project, and ecological restoration monitoring. She completed an internship in greenroof technology in Germany in 2001, and continues to be very active in green community initiatives. She was the Nature Reserves Stewardship Coordinator for the Federation of Ontario Naturalists from 2003 to 2004 and worked extensively on management planning for alvars. Erica is currently an M.Sc. candidate in the Biology Department at St. Mary's University in Halifax, researching plant diversity maintenance in coastal barrens.

COLLECTIONS EXAMINED

No additional herbarium material was examined in the preparation of this update report. In preparing the original status report Crins and Sharp examined specimens from the following herbaria: Canadian Museum of Nature (CAN), Ottawa, ON; Agriculture and Agri-food Canada (DAO), Ottawa, ON; University of Guelph (OAC), Guelph, ON; Royal Ontario Museum (TRT), Toronto, ON; Erindale College, University of Toronto (TRTE), Toronto, ON; University of Western Ontario (UWO), London, ON; University of Waterloo (WAT), Waterloo, ON. They also confirmed that no *F. caroliniensis* specimens were held by the herbaria at Queen's University (QK, Kingston, ON), University of Windsor (WOCB, Windsor, ON), and Wilfred Laurier University (WLU, Waterloo, ON) (Crins and Sharp, 1993).